What is claimed is:

1. A multi-layer passive microfluidic mixing device comprising:

a first microfluidic channel defined through the entire thickness of a first stencil layer

a second microfluidic channel defined through the entire thickness of a second stencil layer; and

an overlap region that promotes mixing between at least two different fluid streams, the overlap region being in fluid communication with both the first channel and the second channel.

2 The mixing device of claim 1 wherein the first stencil layer is adjacent to and in spacerless contact with the second stencil layer.

3. The mixing device of claim 2, further comprising a spacer layer disposed between the first stencil layer and the second stencil layer, the spacer layer defining an aperture for communicating fluid between the first channel and the second channel.

4. The mixing device of claim 3 wherein the first channel has a characteristic width, the second channel has a characteristic width, and aperture is at least as large in major dimension than the first channel width or the second channel width.

5. The mixing device of claim 3 wherein the first channel has a characteristic width, the second channel has a characteristic width, and the aperture is substantially smaller in major dimension than the first channel width or the second channel width.

6. The mixing device of claim 4 wherein the aperture is disposed substantially centered along the width of the first channel and along the width of the second channel.

7. The mixing device of claim 3 wherein the first channel has a characteristic width, the second channel has a characteristic width, and the spacer layer defines a plurality of apertures each substantially smaller in major dimension than the first channel width or the second channel width.

8. The mixing device of claim 3 wherein the aperture is configured in the shape of a slit.

9. The mixing device of claim 1 wherein the overlap region has a characteristic width, and, within or immediately adjacent to the overlap region, contact between the at least two different fluid streams is established along the entire width of the overlap region.

11. The mixing device of claim 1 wherein both the first channel and the second channel are located substantially upstream of the overlap region.

12. The mixing device of claim 1 wherein the first channel supplies a first fluid stream to the overlap region and the second channel supplies a second fluid stream to the overlap region.

13. The mixing device of claim 1 wherein the first channel supplies a stream of a first fluid to the overlap region and the second channel receives a stream of multiple fluids from the overlap region.

14. The device of claim 1 wherein the first channel supplies a stream of multiple fluids to the overlap region and the second channel receives a stream of multiple fluids from the overlap region.

15. The device of claim 14 wherein the first channel includes a junction for merging a first fluid stream with a second fluid stream.

16. The device of claim 1 wherein the first channel is located substantially upstream of the overlap region and the second channel is located substantially downstream of the overlap region.

17. The device of claim 1 wherein the first channel is located substantially upstream of the overlap region and the second channel includes an upstream segment located substantially upstream of the overlap region and a downstream segment located substantially downstream of the overlap region, the upstream segment and the downstream segment being substantially continuous.

18. The device of claim 17 wherein the upstream segment has a characteristic width, the downstream segment has a characteristic width, and the width of the downstream segment is greater than the width of the upstream segment.

19. The device of claim 1 wherein the overlap region includes a third channel defined through the entire thickness of a third stencil layer disposed between the first stencil layer and the second stencil layer.

20. The device of claim 1 wherein, immediately upstream of the overlap region, a first fluid stream is directed in a first direction and, separately from the first fluid stream, a second fluid stream is directed in substantially the same direction.

21. The device of claim 1 wherein upstream of the overlap region a combined stream of multiple fluids travels in a first direction, and immediately downstream of the overlap region the combined stream of multiple fluids is manipulated to undergo a substantial change in direction relative to the first direction.

22. The device of claim 21 wherein the directional change is at least about 90 degrees.

23. The device of claim 1, further comprising a first fluid inlet port and a second fluid inlet port.

24. The device of claim 23, further comprising a third fluid inlet port and a third channel defined through the entire thickness of a third stencil layer, wherein mixing is promoted between more than two fluid streams.

25. The device of claim 1, further comprising an outlet port.

26. The device of claim 1 wherein mixing is promoted by at least two fluid streams in a plurality of different proportions.

27. The mixing device of claim 1 wherein the device is constructed with multiple layers, and the various layers are bonded or fastened together.

28. The device of claim 27 wherein the bonded or fastened layers form a substantially sealed device.

29. A multi-layer microfluidic mixing device comprising:

a first microfluidic channel for transporting a first fluid stream, the first channel being defined through the entire thickness of a first stencil layer;

a second microfluidic channel for transporting a second fluid stream, the second channel being defined through the entire thickness of a second stencil layer;

a microfluidic outlet channel; and

an overlap region for contacting the first fluid stream with the second fluid stream in the outlet channel to promote mixing between the fluid streams.

30. The mixing device of claim 29 wherein the outlet channel has a characteristic height and a characteristic width, and contact between the first fluid stream and the second fluid stream is established in the outlet channel along the entire width of the outlet channel.

31. The mixing device of claim 29 wherein the outlet channel has a characteristic height and a characteristic width, and contact between the first fluid stream and the second fluid stream is established in the outlet channel along an interfacial area that is as least as large per unit length as the greater of the height or the width of the outlet channel.

32. The mixing device of claim 29 wherein, immediately upstream of the overlap region, the first microfluidic channel directs the first fluid stream in a first direction, and the second microfluidic channel directs the second fluid stream in substantially the same direction.

33. The mixing device of claim 29 wherein the outlet channel is defined through the entire thickness of a third stencil layer, the third stencil layer being disposed between and in spacerless contact with both the first stencil layer and the second stencil layer.

34. The mixing device of claim 29, the device further comprising a spacer layer disposed between the first stencil layer and the second stencil layer, the spacer layer defining an aperture that permits fluid communication between the first fluid stream and the second fluid stream.

35. The mixing device of claim 34 wherein the first channel has a characteristic width, the second channel has a characteristic width, and aperture is at least as large in major dimension than the width of the first channel or of the second channel.

36. The mixing device of claim 35, wherein the aperture is configured in the shape of a slit.

37. The mixing device of claim 36, wherein the slit is disposed substantially perpendicular to the direction of bulk fluid flow in first and the second microfluidic channel.

38. The mixing device of claim 34, wherein the spacer layer defines a plurality of apertures

39. The mixing device of claim 38 wherein the outlet channel has a nominal width, and each aperture is substantially smaller in major dimension than the width of the outlet channel.

40. The mixing device of claim 29, wherein the outlet channel is defined through the entire thickness of the second stencil layer and is a substantially continuous extension of the second microfluidic channel.

41. The mixing device of claim 29 wherein:

the second channel is a channel segment upstream of the overlap region;

the outlet channel is a channel segment defined through the entire thickness of the second stencil layer and located downstream of the overlap region; and

the second channel and the outlet channel are substantially continuous.

42. The mixing device of claim 41 wherein the second channel has a characteristic width, the outlet channel has a characteristic width, and the width of the outlet channel is larger than the width of the second channel.

43. The mixing device of claim 29 wherein both the first channel and the second channel are located substantially upstream of the overlap region, and the outlet channel is located substantially downstream of the overlap region.

44. The mixing device of claim 29 further comprising a third microfluidic channel for transporting a third fluid stream, the third channel being defined through the entire thickness of a third stencil layer, wherein the device promotes mixing between the first fluid stream, second fluid stream, and third fluid stream.

45. The mixing device of claim 29, further comprising at least two fluid inlet ports and a plurality of fluid outlet ports.

46. The mixing device of claim 29 wherein the device is constructed with multiple layers, and the various layers are bonded or fastened together.

47. The device of claim 46 wherein the bonded or fastened layers form a substantially sealed device.

48. A microfluidic device for mixing a plurality of fluid streams, the mixing device comprising:

a plurality of microfluidic inlet channels that merge into a microfluidic junction channel, the junction channel being defined in a first device layer and having a characteristic cross-sectional area; and

a plurality of contraction / expansion regions in fluid communication with the junction channel and arranged in series, each contraction / expansion region including:

an aperture defined in a second device layer, the aperture having a characteristic cross-sectional area that is substantially smaller than the area of the junction channel; and

a microfluidic expansion channel defined in either the first device layer or a third device layer, the expansion channel having a characteristic cross-sectional area that is substantially larger than the area of the aperture.

49. The mixing device of claim 48 wherein each aperture is less than about 250 microns in major dimension.

50. The mixing device of claim 49 wherein:

the junction channel contains a stream of multiple fluids;

upstream of an aperture, the stream of multiple fluids flows in substantially a first direction;

downstream of an aperture, the stream of multiple fluids flows in substantially a second direction that is substantially different from the first direction.

51. The mixing device of claim 50 wherein the second direction is at least about 90 degrees apart from the first direction.

52. The mixing device of claim 48 wherein any of the inlet channels, junction channel, or expansion channels are defined through the entire thickness of a stencil layer.

53. The mixing device of claim 48 wherein any of the inlet channels, junction channel, or expansion channels are defined in a surface but do not penetrate the entire thickness of a device layer.

54. The mixing device of claim 53 wherein any of the inlet channels, junction channel, or expansion channels are defined using one or more surface micromachining techniques.

55. The mixing device of claim 48 wherein the device is formed with multiple layers, and the various layers are bonded or fastened together.

56. The mixing device of claim 55 wherein the bonded or fastened layers form a substantially sealed device.

57. A multi-layer microfluidic mixing device comprising:

a plurality of microfluidic inlet channels that merge into a junction channel, the junction channel being defined in a first device layer;

a slit defined in a second device layer, the slit being in fluid communication with the junction channel and disposed lengthwise in a direction substantially parallel to the junction channel; and

a microfluidic outlet channel defined in a third device layer, the outlet channel being in fluid communication with the slit.

58. The mixing device of claim 57 wherein the outlet channel is disposed in a direction substantially perpendicular to both the junction channel and the slit.

59. The mixing device of claim 57 wherein the slit has a characteristic length, the outlet channel has a characteristic width, the slit has a characteristic length, and the length of the slit is at least as great as the width of the outlet channel.

60. The mixing device of claim 57 wherein any of the inlet channels, junction channel, or outlet channel are defined through the entire thickness of a stencil layer.

61. The mixing device of claim 57 wherein any of the inlet channels, junction channel, or outlet channel are defined in a surface but do not penetrate the entire thickness of a device layer.

62. The mixing device of claim 57 wherein any of the inlet channels, junction channel, or outlet channel are defined using one or more surface micromachining techniques.

63. The mixing device of claim 57 wherein the junction channel is substantially upstream of the slit, and the outlet channel is substantially downstream of the slit.

64. The mixing device of claim 57 wherein the device is formed with multiple layers, and the various layers are bonded or fastened together.

65. The mixing device of claim 64 wherein the bonded or fastened layers form a substantially sealed device.

66. A microfluidic mixing device comprising:

a first microfluidic channel defined in a first device layer;

a second microfluidic channel defined in a second device layer;

a slit defined in a third device layer disposed between the first device layer and the second device layer, the slit permitting fluid communication between the first channel and the second channel.

67. The mixing device of claim 66 wherein the first channel has a characteristic width, the second channel has a characteristic width, the slit has a characteristic length, and the length of the slit is at least as large as the greater of the width of the first channel or the second channel.

68. The mixing device of claim 66 wherein the slit is disposed in a direction substantially perpendicular to either the first channel or the second channel.

69. The mixing device of claim 66 wherein any of the first channel or the second channel are defined through the entire thickness of a stencil layer.

70. The mixing device of claim 66 wherein any of the first channel or the second channel are defined in a surface but do not penetrate the entire thickness of a device layer.

71. The mixing device of claim 70 wherein any of the first channel or the second channel are defined using one or more surface micromachining techniques.

72. The mixing device of claim 66 wherein the first channel is substantially upstream of the slit and the second channel is substantially downstream of the slit.

73. The mixing device of claim 66 wherein the device is formed with multiple layers, and the various layers are bonded or fastened together.

74. The mixing device of claim 73 wherein the bonded or fastened layers form a substantially sealed device.

75. A microfluidic mixing device comprising:

a first microfluidic channel defined in a first device layer;

a second microfluidic channel defined in a second device layer; and

a plurality of apertures in fluid communication with the first channel and the second channel, the apertures being defined in a third device layer disposed between the first layer and the second layer.

76. The mixing device of claim 75 wherein the first channel has a characteristic width, the second channel has a characteristic width, and each aperture has a major dimension that is substantially smaller than the width of the first channel or the width of the second channel.

77. The mixing device of claim 76 wherein the major dimension of each aperture is less than about one-quarter of the width of the first channel or the width of the second channel.

78. The mixing device of claim 76 wherein each aperture has a major dimension of less than about 200 microns.

79. The mixing device of claim 76 wherein each aperture has a major dimension of less than about 100 microns.

80. The mixing device of claim 75 wherein the first channel has a characteristic cross-sectional area, the second channel has a characteristic cross-sectional area, each aperture has a characteristic cross-sectional area, and the area of each aperture us substantially smaller than the area of the first channel and the area of the second channel.

81. The mixing device of claim 75 wherein the first channel is substantially upstream of the plurality of apertures and the second channel is substantially downstream of the plurality of apertures.

82. The mixing device of claim 75 wherein any of the first channel or the second channel are defined through the entire thickness of a stencil layer.

83. The mixing device of claim 75 wherein any of the first channel or the second channel are defined in a surface of a device layer but do not penetrate the entire thickness of the device layer.

84. The mixing device of claim 83 wherein any of the first channel or the second channel are defined using one or more surface micromachining techniques.

85. The mixing device of claim 75 wherein the device is formed with multiple layers, and the various layers are bonded or fastened together.

86. The mixing device of claim 75 wherein the bonded or fastened layers form a substantially sealed device.

87. A microfluidic mixing device for mixing different fluids in multiple proportions, the device comprising:

a first microfluidic channel having a forked region for splitting a first fluid stream into multiple sub-streams;

a second microfluidic channel having a forked region for splitting a second fluid stream into multiple sub-streams;

a plurality of overlap regions each contacting a sub-stream of the first fluid with a sub-stream of the second fluid to promote mixing between the fluid sub-streams.

88. The mixing device of claim 87 wherein the device produced multiple mixed output streams each having a different proportion of the first fluid and/or the second fluid.